Dusty surprise around giant black hole

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This artist's impression shows the surroundings of the supermassive black hole at the heart of the active galaxy NGC 3783 in the southern constellation of Centaurus (The Centaur). New observations using the Very Large Telescope Interferometer at ESO's Paranal Observatory in Chile have revealed not only the torus of hot dust around the black hole but also a wind of cool material in the polar regions. Credit: ESO/M. Kornmesser

(Phys.org) —ESO's Very Large Telescope Interferometer has gathered the most detailed observations ever of the dust around the huge black hole at the centre of an active galaxy. Rather than finding all of the dust

in a doughnut-shaped torus around the black hole, astronomers find that much of it is located above and below the torus. These observations show that dust is being pushed away from the black hole as a cool wind—a surprising finding.

Over the last twenty years, astronomers have found that almost all galaxies have a huge black hole at their centre. Some of these black holes are growing by drawing in matter from their surroundings, creating in the process the most energetic objects in the Universe: active galactic nuclei (AGN). The central regions of these brilliant powerhouses are ringed by doughnuts of cosmic dust dragged from the surrounding space, similar to how water forms a small whirlpool around the plughole of a sink. It was thought that most of the strong infrared radiation coming from AGN originated in these doughnuts.

But new observations of a nearby active galaxy called NGC 3783, harnessing the power of the Very Large Telescope Interferometer (VLTI) at ESO's Paranal Observatory in Chile, have given a team of astronomers a surprise. Although the hot dust—at some 700 to 1000 degrees Celsius—is indeed in a torus as expected, they found huge amounts of cooler dust above and below this main torus.

As Sebastian Hönig (University of California Santa Barbara, USA and Christian-Albrechts-Universität zu Kiel, Germany), lead author of the paper presenting the new results, explains, "This is the first time we've been able to combine detailed mid-infrared observations of the cool, room-temperature dust around an AGN with similarly detailed observations of the very hot dust. This also represents the largest set of infrared interferometry for an AGN published yet."

The newly-discovered dust forms a cool wind streaming outwards from the black hole. This wind must play an important role in the complex relationship between the black hole and its environment. The black hole

feeds its insatiable appetite from the surrounding material, but the intense radiation this produces also seems to be blowing the material away. It is still unclear how these two processes work together and allow supermassive black holes to grow and evolve within galaxies, but the presence of a dusty wind adds a new piece to this picture.

In order to investigate the central regions of NGC 3783, the astronomers needed to use the combined power of the Unit Telescopes of ESO's Very Large Telescope. Using these units together forms an interferometer that can obtain a resolution equivalent to that of a 130-metre telescope.

Another team member, Gerd Weigelt (Max-Planck-Institut für Radioastronomie, Bonn, Germany), explains, "By combining the world-class sensitivity of the large mirrors of the VLT with interferometry we are able to collect enough light to observe faint objects. This lets us study a region as small as the distance from our Sun to its closest neighbouring star, in a galaxy tens of millions of light-years away. No other optical or infrared system in the world is currently capable of this."

These new observations may lead to a paradigm shift in the understanding of AGN. They are direct evidence that dust is being pushed out by the intense radiation. Models of how the dust is distributed and how supermassive black holes grow and evolve must now take into account this newly-discovered effect.

Hönig concludes, "I am now really looking forward to MATISSE, which will allow us to combine all four VLT Unit Telescopes at once and observe simultaneously in the near- and mid-infrared—giving us much more detailed data." MATISSE, a second generation instrument for the VLTI, is currently under construction.

More information: Research paper

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